

- 9*** • The length of the column of mercury in a thermometer is 4.0 cm when the thermometer is immersed in ice water and 24.0 cm when the thermometer is immersed in boiling water. (a) What should the length be at room temperature, 22.0°C? (b) If the mercury column is 25.4 cm long when the thermometer is immersed in a chemical solution, what is the temperature of the solution?
- 12** • The pressure of a constant-volume gas thermometer is 0.400 atm at the ice point and 0.546 atm at the steam point. (a) When the pressure is 0.100 atm, what is the temperature? (b) What is the pressure at 444.6°C, the boiling point of sulfur?
- 13*** • A constant-volume gas thermometer reads 50 torr at the triple point of water. (a) What will the pressure be when the thermometer measures a temperature of 300 K? (b) What ideal-gas temperature corresponds to a pressure of 678 torr?

- 19** ••• A thermistor is a solid-state device whose resistance varies greatly with temperature. Its temperature dependence is given approximately by $R = R_0 e^{B/T}$, where R is in ohms (Ω), T is in kelvins, and R_0 and B are constants that can be determined by measuring R at calibration points such as the ice point and the steam point. (a) If $R = 7360 \Omega$ at the ice point and 153Ω at the steam point, find R_0 and B . (b) What is the resistance of the thermistor at $t = 98.6^\circ\text{F}$? (c) What is the rate of change of the resistance with temperature (dR/dT) at the ice point and the steam point? (d) At which temperature is the thermistor most sensitive?

Ch 21–4 • A bridge 100 m long is built of steel. If it is built as a single, continuous structure, how much will its length change from the coldest winter days (-30°C) to the hottest summer days (40°C)?

Ch 21–13* •• A car has a 60-L steel gas tank filled to the top with gasoline when the temperature is 10°C . The coefficient of volume expansion of gasoline is $\beta = 0.900 \times 10^{-3} \text{ K}^{-1}$. Taking the expansion of the steel tank into account, how much gasoline spills out of the tank when the car is parked in the sun and its temperature rises to 25°C ?

Ch 21–49* • A steel tape is placed around the earth at the equator when the temperature is 0°C . What will the clearance between the tape and the ground (assumed to be uniform) be if the temperature of the tape rises to 30°C ? Neglect the expansion of the earth.

25* •• A pressure as low as 1×10^{-8} torr can be achieved using an oil diffusion pump. How many molecules are there in 1 cm^3 of a gas at this pressure if its temperature is 300 K ?

- 27 •• A room is 6 m by 5 m by 3 m. (a) If the air pressure in the room is 1 atm and the temperature is 300 K, find the number of moles of air in the room. (b) If the temperature rises by 5 K and the pressure remains constant, how many moles of air leave the room?
- 32 •• A scuba diver is 40 m below the surface of a lake, where the temperature is 5°C. He releases an air bubble with a volume of 15 cm³. The bubble rises to the surface, where the temperature is 25°C. What is the volume of the bubble right before it breaks the surface? *Hint:* Remember that the pressure also changes.

- 33* •••** A helium balloon is used to lift a load of 110 N. The weight of the balloon's skin is 50 N, and the volume of the balloon when fully inflated is 32 m^3 . The temperature of the air is 0°C and the atmospheric pressure is 1 atm. The balloon is inflated with sufficient helium gas so that the net force on the balloon and its load is 30 N, directed upward. Neglect changes of temperature with altitude and neglect the mass of the air displaced by the load and the balloon's skin in calculating the buoyant force.
- (a) How many moles of helium gas are contained in the balloon?
 - (b) At what altitude will the balloon be fully inflated?
 - (c) Does the balloon ever reach the altitude at which it is fully inflated?
 - (d) If the answer to (c) is affirmative, what is the maximum altitude attained by the balloon?

- 40** • Find the total translational kinetic energy of 1 L of oxygen gas held at a temperature of 0°C and a pressure of 1 atm.
- 44** •• The escape velocity on Mars is 5.0 km/s, and the surface temperature is typically 0°C . Calculate the rms speeds for (a) H_2 , (b) O_2 , and (c) CO_2 at this temperature. (d) If the rms speed of a gas is greater than about 15% to 20% of the escape velocity of a planet, virtually all of the molecules of that gas will escape the atmosphere of the planet. Based on this criterion, are H_2 , O_2 , and CO_2 likely to be found in Mars's atmosphere?

- 48 ••** The class in Room 101 prepares their traditional greeting for a substitute teacher. Ten toy cars are wound up and released as the teacher arrives. The cars have the following speeds.

Speed, m/s	2	5	6	8
Number of cars	3	3	3	1

Calculate (a) the average speed, and (b) the rms speed of the cars.

- 50 ••** Since $f(v) dv$ gives the fraction of molecules that have speeds in the range dv , the integral of $f(v) dv$ over all the possible ranges of speeds must equal 1. Given the integral

$$\int_0^{\infty} v^2 e^{-av^2} dv = \frac{\sqrt{\pi}}{4} a^{-3/2}$$

show that $\int_0^{\infty} f(v) dv = 1$ where $f(v)$ is given by $f(v) = \frac{4}{\sqrt{\pi}} \frac{m}{2kT}^{3/2} v^2 e^{-mv^2/(2kT)}$ (Equation 18–37).